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Author(s): Timothy F. Bresnahan

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Post-Entry Competition in the Plain Paper Copier Market

By TIMOTHY F. BRESNAHAN*

This paper reviews events in the plain paper copier (*PPC*) market immediately after Xerox's monopoly ended. Xerox's behavior and that of a flood of *PPC* entrants are viewed through the lens of recent advances in the theory of entry and entry deterrence. The events of the early post-entry period also cast some interesting light on the theory of technological competition.

The modern theory of entry deterrence rests on a simple, if not obvious, proposition. The (socially) worst industry performance is after entry, the more monopolies there will be, since the interests of the entrant and society are opposed once entry has occurred. A series of papers have considered endogenous changes in the conditions of competition-monopolists who make their industry more competitive (conditional on entry) in order to deter potential entrants.¹ There are two distinct steps in the entry-deterrence argument. First, it must be possible for events during the monopoly period to affect post-entry competition. Some intertemporal complication must be present, either in costs or in firm-specific demand, if the state of the industry at the time of entry is to form important "initial conditions" for competition. Second, the monopolist must find it profitable to manipulate the initial conditions by some pre-entry action.

The general theoretical questions of entry and deterrence have been cast in quite spe-

cific terms for the problem of technological competition. One view emphasizes the "Arrow effect" (Kenneth Arrow, 1962; Jennifer Reinganum, 1983; Drew Fudenberg and Jean Tirole). Because any innovation destroys some of the rents to older products and processes, incumbent monopolists have a smaller incentive to innovate than potential entrants. Another view (Richard Schmalensee, 1983; Richard Gilbert and David Newbery, 1982) points out that the incumbent's losses from entrant's innovation create a motive for preemptive *R&D*, product introduction, or patenting. If incumbents are leaders and entrants followers, the second view will hold independent of technology. Note that the difference is over the profitability of entry deterring strategies. In both views, the presence of valuable assets like patents or secrets provides the necessary intertemporal link.

Events in the *PPC* market during the time of Xerox's monopoly did have a substantial impact on the nature of competition in the early postentry period. An Arrow effect is evident, as are other equilibrium explanations of Xerox's rapid decline. The alternative explanation that Xerox was "fat" is also considered below.

I. The Late Monopoly in *PPCs*

Xerox the monopolist did three things which form the basis for my investigation: it price discriminated, priced far from costs, and patented every imaginable feature of the copier technology. The early entrants (in the early 1970's) and the effects of the FTC consent decree requiring Xerox to license its patents to all comers (in 1975) were substantially affected by the initial conditions at the beginning of the competitive period.

[†]*Discussants*: Richard J. Gilbert, University of California-Berkeley; Paul David, Stanford University; Kenneth Judd, Northwestern University.

*Assistant Professor of Economics, Stanford University, Stanford, CA 94305.

¹See A. Michael Spence (1977); Avinash Dixit (1979); See also papers reviewed by Drew Fudenberg and Jean Tirole (1984).

Xerox used a long list of price discrimination devices.² Among other devices, Xerox based rental prices on the number of machines a customer used, whether different models were rented by the same customer, by the number of copies per month, and by the number of copies per original. Implementation of this price discrimination scheme required a "lease-only" policy. This is the first of the initial conditions of the period of competition. Xerox had an extremely large rental fleet of copiers at the time of entry. As a result, the capital loss on existing copiers due to competitive price falls would be born by Xerox, not by old customers.

The second initial condition was the result of the umbrella provided by Xerox's price-cost margin. In the small (low-volume) copier market segment, "coated paper" copiers held on to a substantial market share despite their great inferiority to *PPCs*. In the high-volume copier/duplicator market segment, photography-based methods remained common despite their cost disadvantage relative to electrostatic copying ("xerography"). Substantial product-development and distribution-network quasi rents in those industries would be destroyed if *PPC* prices fell.

When IBM and Litton entered the *PPC* market in 1972, Xerox sued to block entry under literally hundreds of patents. IBM had spent millions to "invent around" Xerox's major patents—with 25 percent of the budget going for patent counsel, not *R&D*. Later entrants depended on antitrust countersuits rather than plans to defend the patent suits, as did Litton. Over the same time period, the FTC brought another antitrust action. Over the objections of existing entrants (especially SCM), the FTC forced Xerox to license its patents to *all* entrants at nominal costs.³

² This discussion, and much of this paper, is in deep debt to staff work done at the FTC in connection with the Xerox case. Comments by R. Gilbert, F. M. Scherer, and several members of the FTC staff on my larger paper (1985) on which this one is based were very helpful. Factual assertions will not be documented in this paper; citations and more detailed evidence are available in my earlier paper.

³ Existing entrants proposed an arrangement in which they and Xerox would exchange patents.

This was the third initial condition: potential entrants could be reasonably certain as of 1974 that there would be free access to *PPC* technology.

II. The Transition to Competition I: Prices and Market Shares

Plain paper copiers are complex, highly technical products. Models vary in speed, ability to collate, needed warmup time, and reliability. Firms vary in the degree of non-hardware service they bundle to their machines.

Table 1 shows rates of change of prices indexes for *PPCs* calculated on the basis of standard lease contracts for those machines which do not change (hardware) features between years. These indexes are biased upward when new machines are introduced: in general we would expect the price fall from an existing machine to be less than proportional to the (implicit) price fall from a new machine. Yet they show an extremely rapid fall in the price index immediately following entry. Xerox's prices lag entrants' in this period. (1977 was a major new-product year for Xerox, so the "Xerox" column would show a large drop if it could be calculated.) After 1978, price indexes for Xerox (not shown) move quite closely with those for other firms.

The simultaneous existence of rental and purchase markets complicates the calculation of market shares. Two obvious definitions are possible: share in "installed base," total machines in use, and in "net new placements," current sales plus new rentals minus returns of old rental machines. Xerox's share on both definitions was 100 percent in early 1972. Its share of new placements fell to 58.5 in 1973, 43.2 in 1974, 14.1 in 1975, and 13.7 in 1976. Its share rebounded to 44.5 in 1977 and has remained since then in the 40–50 percent range. In installed base, Xerox's share declined steadily to 55 percent in 1977 and declined more slowly thereafter to a current range of about 45 percent.

The curious thing about this particular transition is the dip in Xerox's market share in net new placements. Two points are worth noting. The first is that during the transition

TABLE 1—PPC PRICE INDEXES^a

	Xerox	All Firms
1973	-6.9	-8.4
1974	-12.0	-11.8
1975	-2.5	-5.9
1976	-8.2	-2.7
1977	^b	-7.1 ^c
1978	-6.1	-6.3

^aAverage percent change in real rental price since previous year.

^bNot calculable: insufficient comparable contracts.

^cDoes not include Xerox Corporation.

period, Xerox did not function as a leader relative to other firms. One could either use the language of the contemporaneous trade press—Xerox “passive” and “fat”—or note the incentive effects of the Xerox rental fleet left over from the monopoly period. In the transition period, each addition to the installed base lowers price, and it is Xerox that takes the largest capital loss on that price fall, since Xerox is the owner of the bulk of the inframarginal units. (The intuition here is that of Cournot.) Thus Xerox is at a considerable strategic disadvantage. After Xerox’s installed base declines to what now appears to be Xerox’s steady-state market share, this comparative disadvantage is wiped out.

The second thing to note about the entry period is that the transition took almost five years from initial entry and three years from near certainty that the FTC would allow free entry. The adjustment costs for a *PPC* entrant are nontrivial: a distribution network must be set up, a machine must be designed, and so on. It is hard to imagine, however, that these adjustment costs are particularly large by the standards of manufacturers generally. This long adjustment period suggests that the entry deterrence theories may be correct in those industries, unlike *PPCs*, where initial conditions tend to give incumbents a strategic advantage.

Theories of entry deterrence and of the persistence of monopoly have naturally emphasized those intertemporal cost and demand relationships which give strategic advantages to incumbents. These are relationships of *complementarity* over time. If capital is long lived, higher production dur-

ing the monopoly period lowers post-entry costs. If users of the monopoly product invest in knowledge of how to use it, their demand curves for that specific brand will be shifted out post entry. By contrast, substitutability over time leads to incumbents strategic disadvantage, as in the *PPC* case.⁴ Since photocopiers are a durable good, their demand is characterized by intertemporal substitution, to Xerox’s disadvantage.

Since a large fraction of modern monopolies are producers’ durables, there seems to be a presumption that the most common strategic effect is incumbents’ disadvantage. This presumption is too hasty, however. At least in electronics, monopoly products are frequently associated with substantial investment in information goods by downstream firms. For example, mainframe computers require downstream investment in software and in human capital, which can lead to a substantial complementarity over time in single-brand demand. This may well give IBM a strategic advantage, contributing to its continuing dominance.

III. The Transition to Competition II: Innovation

The transition period saw a great deal of innovative activity from entrants and Xerox. It is possible to say something about the impact of competition on the direction of inventive activity based on this experience, although little information is provided about the rate of activity.

The new-product choices of firms whose rents were destroyed by the increase in *PPC* competition are illuminating. We can divide these firms into three groups: producers of coated paper copiers (*CPCs*), producers of photocopiers, and Xerox, a full-line *PPC* manufacturer. The producers of *CPCs*, having substantial marketing and distribution expertise in the small-volume copier segment, would seem to be a natural group of

⁴This discussion presumes that the incumbents’ products and the entrants’ products are in a relationship of “strategic substitutability” post entry. See Jeremy Bulow et al. (1984) and Fudenberg and Tirole for a fuller discussion of the strategic issues.

entrants into the *PPC* business. Most did enter, but not into the small-volume segment: in 1976 a group of these firms (SCM, Dennison, AM, A.B. Dick, and Royal) was offering more than three times as many high-speed as low-speed copiers. There was very substantial entry into the low-volume segment, overwhelmingly by firms not previously in the market (Savin, Ricoh, etc.). With the exception of Kodak, which continued to offer differentiated high-volume copiers with all available technologies, photocopier manufacturers did not enter the *PPC* market. Xerox introduced new products in all segments. As a regularity, firms that had a choice chose to enter product segments where higher rates of inventive activity would destroy others' rents, not their own.⁵

As in the last section, we see that initial conditions matter for competition, and in the way suggested by the theory. It is again the incumbent's strategic disadvantage that shows most clearly in the *PPC* case. The logic of the entry deterrence theories is vindicated, but there is no presumption that the demand and technological conditions leading to the persistence of monopoly are common.

Verifying the generality of the *PPC* experience is no easy task. One might be tempted simply to ask whether monopolies and near-monopolies persist in high-technology areas. But all theories will imply that, in a suitably uncertain world, some monopolies will persist and others will not. No preemption theorist feels the results are weakened by RCA's failure (during the 1950's) to preemptively invent processes for producing integrated circuits, nor can any believer in the Arrow effect rule out the theoretical possibility that IBM simply built a better computer than Burroughs (in the 1960's).

⁵Though the immediate post-entry period saw a very rapid increase in the overall level of *PPC* innovative activity, it is not possible to draw any conclusions about the relationship between competition and innovation. It would be extremely difficult to distinguish the effects of important changes in technological opportunity, such as those resulting from the invention of the micro-processor, from changes in the conditions of competition.

IV. What is "Fat?"

The trade press of the transition period made much of the idea that Xerox was "losing" because it was fat, language not particularly attractive to economists. There is hard evidence of this fat, however. In the monopoly period, using very successful price discrimination devices, Xerox had price-average cost margins of around 10 percent. From 1972-76, a period with no important advances in *PPC* manufacturing process, prices of standard contracts fell by 30 percent and Xerox's price-discrimination practices ended. Other firms found it profitable to operate at the new prices. Xerox's accounting average cost must have overstated true marginal cost by at least 20 percent.

The trade press also offers a view of the differences among companies' technological tendencies which may imply a theory of where the money went. In the monopoly period, Xerox was a highly innovative firm. But the innovations were characterized by being "in the copier." These were purely technical advances in the quality of reproduction, as well as such features as two-sided copying, reduction, etc. The innovations by entrants include some of a very different character, those oriented toward the "user interface." Entrants introduced document feed devices (Kodak 150), automated many of technical features like two-sided copying (IBM III), and invented whole new product markets like the "convenience copier" (Savin 750.) One of the natural claimants for the rents in a high-technology activity is the engineering staff, not capital. Since capital in fact owns the rents, this requires an explanation of a failure of monitoring. Though taking the rents in the form of cash may be easily monitored, taking the rents in the form of a persistent bias away from the highly commercial activity toward activity of more purely engineering interest may be much more difficult to monitor.⁶

⁶This theory is complementary to Michael Salinger's (1984) observation that union labor may claim the rents.

V. Conclusion

This attempt at an industry case study may well appear clumsy to experienced practitioners of the art. I note only my surprise at how helpful recent advances in economic theory can be in understanding real competition.

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